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Professional Development Experiences Designed to Develop Teachers' Empathy and Engagement with Emergent Bilinguals in Mathematics

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Abstract

In this study, we explore the impact of professional development (PD) on teacher empathy and engagement with emergent bilingual (EB) students in mathematics classrooms. Advancing Inquiry in Middle Mathematics for Rural East Texas (AIMM) a two-year A PD project, targeting teachers in rural schools, aimed to shift teaching beliefs from directive to connected approaches and to increase content knowledge. Three activities are described in detail. During the tasks, teachers experienced the perspectives of EB students, fostering empathy and enhancing their instructional strategies. Pre-post data and monthly reflections demonstrated shifts in teaching practices, highlighting increased use of cognitively demanding tasks and improved teacher-student interactions. Teachers reported greater cultural awareness and understanding of EB students, attributing these changes to the empathetic experiences provided by the PD. Our findings highlight the necessity of incorporating empathy in PD to support diverse students' emotional and cognitive needs, ultimately promoting inclusive and effective teaching practices. These findings suggest that empathy-focused PD can mitigate unproductive teaching beliefs and enhance the learning environment for all students.

Keywords:

Teacher Empathy, Professional Development, Emergent Bilingual Students, Mathematics Education

Introduction

In the United States, student demographics continue to evolve and grow rapidly across public schools. Among these fast-growing groups is the emergent bilingual student population. According to the National Center for Education Statistics (NCES, 2023), there were 5.0 million emergent bilingual students (EBs) in the United States in 2020. This demographic shift necessitates the development of strategies within school districts to accommodate the academic needs of this growing population. Texas alone has approximately 1,269,408 EB students, comprising 23.1% of the student population (Texas Education Agency [TEA], 2023a). Unfortunately, school administrators and teachers often lack adequate support or professional development

(PD) training to effectively address EB students' academic, cultural, and linguistic needs.

Using mathematics as a pathway, teachers can enhance teacher-student engagement, incorporate culturally relevant learning opportunities, and better understand EB students' cultural and linguistic backgrounds. This approach may significantly increase academic achievement levels. Professional development for teachers, focusing on increasing content knowledge in mathematics while considering students' cultural backgrounds and incorporating culturally relevant materials, can collectively impact teachers' beliefs about instruction and learning, potentially rectifying previously counterproductive beliefs.

The Advancing Inquiry in Middle Mathematics for Rural East Texas (AIMM) two-year professional development project focused on increasing teachers' content knowledge and shifting beliefs about teaching and learning mathematics from a "teaching as telling" approach to teaching math as a connected set of ideas (Plowman & Lynch-Davis, 2021). The authors acknowledge that beliefs are not directly associated with teacher empathy, but experiences that support teachers in connecting with students through cultural awareness and stepping into students' shoes as problem solvers can foster an empathetic disposition. This empathy can subsequently change unproductive beliefs about teaching and learning mathematics and enhance teachers' understanding of their students.

Professional development tasks build teacher empathy by encouraging thoughtful reflection on students' perspectives and intentional engagement with students in the content (Rieckhoff et al., 2020). Teachers' command of mathematics content supports their understanding of student thinking (Namakshi & Washauer, 2022), and this understanding is linked to how well students learn (Carpenter et al., 1989). Teachers' low self-efficacy in math negatively impacts students' success when teachers assume students are like themselves (Gulistan et al., 2017). Lampert et al. (2021) found that when teachers extend empathy to better understand student engagement in mathematics, they revise deficit thinking about students. The connection between self-efficacy and student success is explained by teachers' ability to empathize with students (Goroshit & Hen, 2016). Empathy allows teachers to align with students' perceptions, feelings, and thinking, leading to adequate support and responses during instruction, which, in turn, leads to student success.

Experiences that support teachers in connecting with EB students through understanding their cultural backgrounds (cultural and linguistic awareness), life experiences, and incorporating culturally relevant materials are fundamental to the student's growth and development (de Araujo et al., 2018; Domínguez, 2011; Moschkovich, 2007). Building these connections allows teachers to step into an EB student's shoes as problem solvers and develop an empathetic disposition, which can change unproductive beliefs about teaching and learning mathematics.

In this study, we address the following research questions: (1) How does professional development focused on cognitively demanding tasks impact teachers' beliefs and practices regarding engagement with emergent bilingual (EB) students? and (2) In what ways does the PD influence teachers' development of empathy and cultural awareness when working with EB students in mathematics instruction? To build the context of this study, we included details of three specific professional development tasks. To address the questions, we analyzed teachers' evolving beliefs and practices as captured through their monthly written reflections during the second year of the project.

Literature Review

Teacher Empathy

Empathy for students is distinct from sympathy for students (Lesley University, n.d.). While important in demonstrating teachers care for students, sympathy involves feeling for the students from one's own perspective. In contrast, empathy involves understanding another person by considering their point of view and experiences. Empathetic teachers of mathematics relate to students both affectively and cognitively. Understanding the emotions associated with content and learning from the student's perspective supports effective, responsive teaching (Jaber et al., 2024). Empathy plays a fundamental role in mathematics education, particularly when teaching culturally diverse students. According to Askew et al. (1997), effective teachers of numeracy are those who demonstrate an understanding of students' individual needs and backgrounds, which is essential for engaging students who might otherwise feel disconnected from the material. This is consistent with the findings of Roberts (2020), who stress the importance of positioning ELLs within mathematics classrooms through strategies that are inclusive and responsive to their cultural identities. Such approaches allow students to see their experiences and cultures reflected in mathematical concepts, which increases engagement and relevance. Moreover, the principles outlined by the Advisory Committee on Mathematics Education (ACME, 2006) suggest that empathy in teaching mathematics promotes not only cognitive understanding but also emotional connections to the material, making it more meaningful for students.

This empathetic and culturally responsive stance aids teachers in identifying and addressing potential

barriers to learning, thus fostering a more inclusive learning environment. This aligns with the findings of McAllister and Irvine (2002), who expressed that empathy enables teachers to connect with students in ways that are both genuine and respectful of their unique cultural backgrounds. In their study, the authors asserted that teachers who approach their students with empathy can foster stronger, more authentic relationships, which is foundational for creating a supportive learning environment. This empathetic approach not only enhances relational bonds but also allows teachers to incorporate culturally responsive teaching methods effectively (McAllister & Irvine, 2002).

Empathy and Student Success

Studies show that connecting with students through understanding their work and thinking leads to positive outcomes (Carpenter et al., 1989; Fast et al., 2010). Understanding how students think and valuing their problem-solving strategies reflects teacher empathy. These empathetic instructional characteristics have been linked to student achievement (Carpenter et al., 1989) and teachers' content knowledge (Copur-Gencturk et al, 2019). Warshauer (2015) claims that students learn concepts deeply when they engage in productive struggle and suggests that students are more willing to take risks if teachers create a caring atmosphere. This skill of responsive teaching is strongly related to teacher empathy. As Jaber (2021) explains, "Attending to both affective and cognitive aspects of teacher learning can help us appreciate how teachers develop epistemic empathy—a capacity for tuning into and valuing students' intellectual and emotional experiences within an epistemic activity—in ways that foster teachers' responsiveness" (p. 434).

Empathy, Beliefs, and Task Implementation

It is imperative that educators believe that every student can engage in meaningful and significant mathematics. Teachers' ability to respond to students when using cognitively demanding tasks (CDTs) depends on their capacity to listen and suspend evaluation (National Council of Teachers of Mathematics [NCTM], 2014). Teachers may avoid offering CDTs or reduce its demands for students perceived as less advanced, including those labeled as having a learning disability or as non-fluent in English (Monarrez & Tchoshanov, 2020). Engaging in CDTs provokes elements of productive struggle. Students engage in productive struggle when they grapple within their zone of proximal development to make sense of high-demand tasks (Dixon et al., 2015; Hiebert & Grouws, 2007; Vygotsky, 1978). Furthermore, when teachers offer cognitively demanding tasks, unproductive beliefs about struggling students often lead them to reduce the demands, thereby undermining productive struggle (Junk, 2005; Campbell et al., 2014; Cengiz et al., 2011). When teachers fail to empathize with students, these unproductive beliefs limit their responses and understanding of students. Empathetic teachers of mathematics relate to students both in affect and knowledge. When teachers understand the emotions related to content and learning together from the student's point of view supporting effective, responsive teaching (Jaber et al., 2024).

Empathy and Cultural Awareness

Teachers who have the opportunity to learn about students from different cultures and their lived experiences can develop empathetic perspectives and leverage student backgrounds to support success in mathematics. Downey and Cobbs (2007) reported on a task that required preservice teachers to conduct a math interview with a child from a different culture. These interviews "provided a window for preservice teachers to view the teaching and learning of mathematics through the eyes of the child as a learner" (p. 399). Cultural awareness deepens teachers' understanding of students from diverse backgrounds and encourages using cultural strengths during lessons. The importance of cultural awareness and addressing unproductive beliefs about students is highlighted in the work of Hunter et al. (2020) in the Developing Mathematical Inquiry Communities (DMIC) project in New Zealand. In this project, professional development activities shifted teachers' expectations of students' mathematical capabilities by exposing them to the cultural traditions and beliefs held by New Zealand Māori and Pacifica students and parents. Domínguez (2011) emphasizes the importance of recognizing diverse students' out-of-school experiences and first languages: "By providing bilingual students with opportunities to use their two languages to think mathematically, along with the everyday experiences that matter in their lives, students can express, share, and negotiate meanings and ideas in ways that more fully demonstrate their mathematical productivity" (p. 325). Moscovitch (2007) further explains that connecting with students through culture supports "bilingual students' engagement in conversations about mathematics, going beyond translating vocabulary and involving students in communicating about mathematical ideas" (p. 20).

Background: The AIMM PD Project

Pre-post data from a pilot PD led by two of the research team in 2017-2018 showed increased content knowledge and changes in beliefs about teaching and learning, indicating that teachers were moving away from a transmission model of teaching-to-teaching math as a connected set of ideas (Plowman, 2020). Additionally, teachers were surveyed to determine how many tasks presented in the PD sessions were used in their lessons. Survey results indicated that over half of the teachers used the tasks fewer than five times, with some not using any of the tasks. Teachers

indicated that fast-paced curricula, testing pressures, and concerns about how the problems might work with students in regular classes were barriers to using the tasks during instruction.

Using what was learned from the pilot, the team gained funding for the project examined in this study. The AIMM professional development (PD) project was a two-year initiative (2018-2020) designed and led by seven professors from four universities. This project targeted teachers of grades 5 through 10 in rural schools across 39 counties. Many of these schools had growing numbers of students who identified as emergent bilingual. An emergent bilingual student is defined as "a student who is in the process of acquiring English and has another language as the primary language" (TEA, 2023b). In Texas, the terms emergent bilingual (EB) and English learner (EL) are used interchangeably, and we also used these terms interchangeably for the purposes of this project. The AIMM project conducted pre-post surveys which indicate that study teachers shifted their beliefs about teaching and learning from a directive approach to a connected approach (e.g., Swan, 2007) and increased their content knowledge (Plowman, 2020). PD leaders realized that the challenges of implementation needed to be addressed more intentionally.

Like the pilot, the two-year AIMM PD consisted of two 7-day summer workshops and two follow-up sessions each year (2018-2020) to develop deeper content knowledge and support teachers in modifying their instruction to include more student-centered, problem-based approaches for all students. Two of the four authors of this paper designed and led key components of the study presented here. One author documented teacher decision-making and beliefs about students in math class, while the second author provided analysis and feedback on the development of tasks to increase teachers' understanding of English language learners (ELLs). The three tasks detailed here were designed to explicitly address decision making and beliefs about learning math in a problem-solving classroom, especially for EB students. To engage teachers closely with the student perspective, the design included play-acting and improvisation as they engaged with the tasks.

PD Tasks: Integrating Empathy and Cultural Responsiveness During Professional Development for Mathematics Instruction

When developing the agenda for the second year, more tasks centered on implementation issues. For example, teachers were asked to bring in student work to document in detail the questions they asked for two lessons. PD tasks deliberately positioned the teachers as students and were specifically targeted to teaching ELLs/Emergent Bilinguals during PD sessions. All three of the PD tasks included here involved some play-acting or improvisation to put the teachers into the student's shoes, with special attention to EB students during debriefing. Essentially, these PD experiences were helping teachers develop empathy for students.

All aspects of the AIMM PD focused on the effective mathematics teaching practices described in Principles to Actions (NCTM, 2014). The three tasks described in this paper specifically target these principles:

- Implement tasks that promote reasoning and problem-solving.
- Facilitate meaningful mathematical discourse.
- Pose purposeful questions.
- Support productive struggle in learning mathematics.

Productive Tasks

The role of well-designed tasks cannot be overstated. Good tasks provide the space and mediation necessary for productive student engagement. We believe that the overall professional development (PD) tasks experienced in the AIMM PD and the tasks teachers learned to implement with their students embody the characteristics of Cognitively Demanding Tasks (CDTs). CDTs involve making connections, analyzing information, and drawing conclusions (Smith & Stein,1998). Research by Desimone et al. (2013), Stein and Lane (1996), and Henningsen and Stein (1997) found that the use of cognitively demanding tasks leads to better student outcomes. Studies support the idea that better content knowledge and positive beliefs about students' capacity to learn predict teachers' frequency of use of CDTs and improve their abilities to maintain cognitive demand when dealing with struggling students.

The TIMSS 1999 video study classified lesson tasks as procedural or connecting and then classified the tasks to determine if they remained as intended. This study showed that while American lessons featured some problems that could be implemented as connected, almost all were taught procedurally, meaning students simply followed the teacher's explicit directions to solve the problem (Heibert et al., 1999). Connecting tasks are stated in such a way that students connect previous learning and understanding to solve the problem rather than being told how to solve it directly. A primary goal in the AIMM PD was to help teachers maintain the connected features of the tasks during implementation.

The three PD tasks helped teachers connect to the student experience by focusing on teacher responses and questioning, linguistic challenges, and cultural awareness. To build teacher empathy for the student's

mathematical experience, each task asked teachers to imagine they were students themselves when problem-solving and to reflect on their feelings about the experience. While many of the tasks during the two-year PD involved challenging mathematics for the teachers, some tasks were designed to frame pedagogical issues in math class and could also serve as tasks they could directly use in lessons with their students. The PD emphasized maintaining the task demand for students for all tasks, even when they may not have been cognitively demanding for teachers.

The Tasks

Make 24, the Division Task, and La Rosca de Reyes each encouraged reflection on student perspectives toward learning and understanding mathematics. Each experience provided a space for discussion of affective components in effective lessons through building empathy for the student perspective. These task sessions concluded by posing questions about how they felt as learners (and pseudo-students) during the lesson, thus highlighting the importance of an empathetic perspective toward the student experience.

Make 24 addressed how students might feel during math class if they sense that teachers may be treating them differently than their peers, particularly in the type of support received when struggling to solve problems. During the Division Task, teachers "wore the shoes" of the ELL learner and experienced a reversal of linguistic roles as well as the impact of task design. In the La Rosca de Reyes, teachers experienced the power of including traditions from other countries, especially those from which their students were associated. In all cases, leaders invited empathic stances as a way to understand students and the impact of using productive tasks as a path forward to support all students.

Make 24 Task

The PD implementation of the Make 24 task involved role play by the PD leaders and teachers. Leaders played the role of teachers, and teachers acted as students. To assign the roles of students, playing cards were used that signified to the leader-teachers the role each teacher-student was to assume. Each teacher received a playing card, with their role determined by the card's number. These roles were designed to reflect teachers' perceptions about their students (often implicit). The teacher-students were unaware of their assigned roles; only the leader-teachers knew the card meanings. A teacher-student holding a card numbered 2, 3, 4, or 5 was to be ignored; those holding cards 6, 7, 8, or 9 were heavily directed or told what to do (representing a reduction of cognitive load), and those with cards 10, Jack, Queen, King, or Ace were supported with assessing and advancing questions (see Smith & Stein, 2018) to simulate maintenance of cognitive load. Teacher-students were asked to solve the task as their students would and to remain in a student's role.

The Make 24 task asks the problem solver to use any of the four operations to make a total of 24 with just four different numbers. There are many versions of this game. Our version used a deck of playing cards in which each numbered card represented its face value; aces were 1, and face cards were 10. Players worked to construct an equation from four randomly selected cards from the deck to total 24. In a problem-solving, student-centered classroom, the task works well because it invites a variety of solutions and clear explanations and justifications. The task also offers opportunities for students to use mathematical notation and conventions, especially order of operation rules.

Teacher-students sat at tables in mixed groups. Each leader-teacher performed all three kinds of response patterns during the mock teaching episode as they worked with their teacher-students at sets of tables. This PD task set-up created mini-classroom settings within our large group (~90 participants), with each leader-teacher leading a lesson for 15-20 teacher-students. During task work time, responses to teacher-students from their "teachers" were dramatized to enact responses of ignoring students, reducing cognitive demand, or maintaining cognitive demand dependent on which card was in front of the student.

Upon completing the lesson, participants were asked how they felt during the lesson as the leaders acted as their teachers to interact with them as students. Responses to being overtly told what to do versus being supported through questioning were as expected. Participants preferred being supported through questioning and probes but disliked being told exactly what to do. One participant who experienced the "directly told" response pattern (reduce cognitive demand) said, "You just told me what to do and then told me the answer." Another remarked that they were asked about the problem but were told what to do before they even had a chance to get started. One reported that the first thing the teacher said was what they did wrong and that they had not used the right strategy, saying, "It's like they were always giving me the answer." A teacher in the assessing and advancing (maintain cognitive demand) group noted, "She [the teacher] was very nice and was listening to me explain, and I was talking a lot, and she was just listening."

Teachers' reactions to the ignoring pattern, however, were surprising. While some teachers felt that ignoring caused resentment or frustration, many ignored participants responded in several ways, sometimes saying they "enjoyed being left alone" and watched

what was happening with other people at their tables. One person felt "offended" and said, "when I asked for help, you just said I'll get back to you, and you never came back." Some teacher-students in the ignored group commented that they were glad they were not "singled out." They reported they felt invisible and safe!

Leaders noted that in classrooms where students may not want to engage, being ignored provided a safe space as they could avoid explaining their thinking. This reaction of liking to be ignored promoted discussion about helping students through questioning without making them feel out of place, and the challenges of addressing mistakes without directly telling students how to solve problems. It also provided an opening to discuss communication alternatives such as gestures, drawing, and pairing with other students in cases where students resist talking and welcome being ignored. Teachers suggested that an EB student might be either ignored or told what to do because the teacher might also avoid conversation with them.

The Division Task

Many teachers do not feel prepared to meet the needs of emergent bilinguals (EB) (Lucas, 2012). For the predominantly English-speaking teachers, the Division Task was designed to help them empathize with how their emergent bilingual students might feel when learning mathematics. This was achieved by conducting the PD session entirely in Spanish. The professional development throughout the year emphasized the importance of cognitively demanding tasks and productive struggle; it became evident that engaging emergent bilinguals in productive struggle could be challenging if teachers did not recognize the issues encountered by students who are faced with learning in a second language.

The task context was cognitively challenging for teachers, requiring them to consider an unfamiliar algorithm for division commonly used in Spain and South America (Ewing, 2017). We want to note that, in general, cognitive demand involved in learning procedures without connections is considered low (see Smith & Stein 2018). However, this task was selected because it illustrated several important points. First, it exposed teachers to the experience of learning even a simple procedure in an unfamiliar language. Next, it promoted discussion about how a word or story problem might facilitate understanding of a concept if the context is elaborated, or conversely, create more challenges if the context is not illustrated or unfamiliar to some students. Additionally, our teachers had the opportunity to see alternate algorithms for division, which many older students from other countries may be familiar with.

To begin the task, teachers were asked to speak only Spanish for the lesson. They were instructed to sit quietly and avoid speaking in English if they could not speak Spanish.

Figure 1.

Teachers were provided with a worksheet with 12 problems to work (4 shown).

Nombre .....

Resuelve los siguientes problemas[1]:

1:	*2:*	*3:*	*4:*
1485 | 45	5525 | 85	4592 | 56	18.936 | 24

Next, one of the authors presented a demonstration of the algorithm in Spanish (an example can be found in Ewing, 2017 to see how this works). Teachers struggled to follow the instructions, and many eventually stopped trying. Having to speak and understand Spanish while using an unfamiliar algorithm that had to be strictly followed made the task very difficult for them.

Some teachers guessed that they were being asked to divide and rewrote the problems to solve using the American algorithm. The leader crossed out their work and told these teachers in Spanish that they had to solve the division problems as demonstrated. They then stopped working on the problem as well. One teacher, who was born in Russia, was able to solve the problems because she was familiar with that algorithm. The leader asked her in Spanish to explain to the others, in Spanish, how she had solved the problems. The teacher shook her head with wide eyes, mouthing "no."

After five minutes, all the teachers stopped working on the problems. They were asked to reflect on the following questions in pairs:

1. How did you feel learning math in Spanish?

2. How could I have taught you better?

As the teachers discussed their experiences, leaders listened to their conversations. The general consensus was that the teachers felt frustrated and "stupid." They expressed that they would have been able to solve the problems if the instructor had spoken more slowly, modeled how to solve the problems, and translated some of the words. One teacher shared with the rest of the group, "Now I know how my English language learners feel in my class. I have been to workshops about ELLs, but now I truly understand how they feel."

After the simulation, teachers were asked if they would like math if it were taught this way. They unanimously said they would not. Teachers noticed that the lesson's emphasis on a specific procedure impeded their engagement to learn content. In addition to considering the experience of learning in Spanish, teachers noticed that the lesson illustrated how a procedurally focused, teacher-directed lesson

limits engagement and provides little connection for students who may be less fluent in the language. The experience challenged the teachers' understanding of mathematics and the common belief that mathematics is language-free. A few teachers initially said the issue was irrelevant to them because they had no bilingual students in their classrooms, as their students were no longer receiving ESL services. This task revealed that teachers could have students struggling with language without being identified by language assessments, as is often the case with emergent bilingual students. The Division Task challenged teachers' beliefs about teaching procedures and set the stage for considering the struggles non-native English speakers might experience.

The Rosca De Reyes Task

Open-ended tasks, while challenging, provide opportunities to engage and support student struggle and success while maintaining cognitive demand. The Rosca De Reyes Task presented an open-ended word problem set in a cultural context, accompanied by dramatic play to illustrate, and practice the kind of productive teacher-student interaction one could have with an emergent bilingual in the midst of a problem-solving lesson. Specifically, the PD task was aimed to build an understanding of open-ended tasks and the opportunities that non-native English speakers could have if word problems included a context from their own culture.

The Rosca De Reyes is part of a pair of holidays celebrated in many Hispanic countries (e.g., Spain, Mexico, and other Latin American countries) as the biggest celebration during Christmas time: Dia de Reyes and Dia de la Candelaria. Rather than celebrating Christmas on December 25th, many Hispanic families celebrate gift-giving on January 6th, known as "El Dia de Reyes" or Three Kings Day. The night before El Dia de Reyes, children leave water out for the camels and go to bed, anticipating that the Three Wise Men will bring presents to be opened the next morning. A significant part of El Dia de Reyes involves Latinx families eating the Rosca de Reyes, a round cake with a plastic figure of the baby Jesus hidden in one of the slices. In Mexico, the tradition is that whoever finds the baby in their slice must host the next party on February 2nd, known as Dia de la Candelaria or Candlemas Day. For more information on these holidays, visit History of Los Tres Reyes (http://www.mexonline.com/history-lostresreyes.htm) and El Dia de la Candelaria (https://www.inside-mexico.com/el-dia-de-la-candelaria-1/).

After sharing the story of these two celebrations, teachers were asked to consider what a student whose family celebrates these holidays might be feeling on these days, given that they will have to go to school on January 6th and February 2nd. "How might students feel if we recognized these holidays?" and "How would most school students feel if they had to go to school on December 25th?" (authors acknowledge that not everyone in the U.S. celebrates Christian holidays). The teachers considered these cultural and emotional implications before reading the Rosca de Reyes task.

Figure 2.
Rosca de Reyes story presented to teachers during introduction of the task.

> *It is Christmas time and Veronica is excited. Now that she lives in the United States she celebrates Christmas, but her favorite part of the holiday is still on January 6th (El Dia de los Reyes.) She loves eating Rosca de Reyes. The cake is delicious, but the best part is guessing who will get the hidden baby in their slice. Last year her uncle got the plastic baby in the cake. Everyone says that whoever gets the baby has to host a party on February 2nd, Dia de la Candelaria—Veronica doesn't think they will make her host a party but she wonders, "Will my slice of cake have the baby?" What is the probability that the plastic baby will be in Veronica's slice of cake?*

To begin, teachers discussed the problem scenario above. They noticed that the task was open-ended and required the problem solver to add details such as the number of people sharing the cake, the sizes of the slices, and even the possibility of more than one baby hidden in the cake (different numbers of plastic babies are a variation in the holiday tradition). In pairs, teachers discussed the task design and how it might engage students. Teachers were asked how they might maintain cognitive demand and support productive struggle. How would they avoid giving too much help or directly suggesting strategies as students work on the problem (e.g., Dixon et al., 2015; Hiebert et al., 2007)?

PD leaders considered having them read transcripts of interactions and propose the next steps by writing a continuation of the scene. Instead, leaders chose to act out the transcript as a skit, with one of them acting as the teacher and the other as the student. Two PD leaders dramatized the task so teachers could think about possible student-teacher interactions and consider ways of supporting student thinking. By watching the scenes acted out, teachers might become more involved than they would if they just read them.

The script featured an extended interaction between a fictional student, Veronica (an emergent bilingual), and her teacher as she began to work on the task. The script was written using our experiences working with children from diverse cultures. It was broken into seven student-teacher interactions to stage decision-making moments where teachers would need to maintain cognitive demand while supporting student engagement (see Appendix A). After each interaction,

teachers were asked to discuss the interaction to consider the teacher's response patterns. Each segment was acted as dramatically as possible and actors broke character between the segments. The first script was just two lines. (The teacher approaches Veronica, an ELL student, who is having difficulty getting started.)

Teacher: Do you like Rosca?

Veronica: (shyly)Yes. I like it.

After each scene was performed, teachers were asked to consider the interaction and its consequences. For example, a simple question like "Do you like Rosca?" invites students to share their feelings and provides an opportunity to understand the story problem context before being asked mathematical questions. All the scenes and the reasons for each are detailed in Appendix A. The scenes included interactions supporting productive struggle, maintaining cognitive load, justifying solutions, and instances in which key vocabulary was translated into Spanish by the teacher.

After all seven scenes were finished, teachers were asked to work in pairs to create additional scenes or scripts that could follow the seventh exchange between the teacher and Veronica. They were asked to justify and analyze the reasoning for the scene and dialogue. The session concluded with a whole group discussion using the following questions:

1. Was this set of interactions an example of productive struggle?
2. How did the teacher maintain cognitive load?
3. How did the assessing and advancing questions in the interactions invite Veronica to continue working on the problem?

Teachers remarked that the student's ability to connect to the problem and to make choices provided meaningful access to the task. They noted the importance of purposeful questioning to support English Language Learners (ELLs) and Emergent Bilinguals (EBs), as well as any student who might struggle with understanding the problem. For example, one teacher mentioned that it would be necessary for Veronica to realize that the probability of finding the plastic baby would be proportional to the size of the cake. Another suggested having Veronica draw the cake so the teacher could assess if she envisioned all the slices as the same size.

One teacher noted the potential challenge of teaching if each student had a different problem. However, she recognized that it could work to take turns, suggesting that on one day, students could solve Veronica's version of the math problem, and the next day, they could use another student's idea. Teachers acknowledged that the problem design could engage all students' ideas and that varying the numbers of people eating the cake could develop concepts of probability and proportional reasoning embedded in the problem (e.g., more people, less chance of getting the baby; larger slices, fewer pieces, and higher chance).

Finally, the cultural context of the problem scenario was addressed, and teachers discussed how other cultural events could be used similarly to enhance student engagement and understanding. This approach emphasized the importance of incorporating cultural relevance in teaching to support all students' learning experiences effectively.

Methodology

Participants

In this study, we initially recruited 97 teachers, of whom 87 provided demographic information. The participating teachers represent various educational levels: 33 teachers (37.93%) from high schools, 21 teachers (24.14%) from middle schools, 10 teachers (11.49%) from intermediate schools, 11 teachers (12.64%) from elementary schools, and 12 teachers (13.79%) from schools without a specified level. These educators have an average of 8.6 years of teaching experience, ranging from 0 to 42 years, and their average age is 39.9, ranging from 23 to 62 years. The gender distribution includes 9 males and 78 females. Among these 87, 80 teachers participated in the "Last Monday Monthly Survey" (see Appendix B).

Data Analysis Procedures: Thematic Analysis

Thematic analysis was conducted to identify, analyze systematically, and report patterns within the data. Following Braun and Clarke's (2006) six-step framework for thematic analysis, we began by familiarizing ourselves with the data and reading through teachers" responses to project evaluation questions and "Last Monday" reflections multiple times to gain a comprehensive understanding of their experiences and insights. Next, we generated initial codes focusing on specific aspects such as cognitive demand, cultural awareness, empathy, and instructional strategies, which emerged as recurring themes across the dataset.

We then collated these codes into potential themes, examining connections and distinctions among them. For example, codes related to teachers' strategies for supporting students without lowering cognitive demand were grouped under the theme "Supporting and Maintaining Cognitive Demand," while those addressing teachers' growing cultural awareness and empathy were categorized into "Teacher Insights on Cultural Awareness and Diverse Learning Needs."

The themes were then reviewed and refined to ensure they accurately reflected the data and captured the breadth and depth of teachers' experiences. This process involved refining the themes to encapsulate meaningful insights, such as "Affect and Empathy," which highlighted teachers' emotional understanding of their students' struggles and growth. Finally, themes were defined and named to convey their essence, followed by illustrative excerpts from teachers' responses that provided rich, authentic examples of each theme. This rigorous approach allowed us to draw meaningful conclusions about the impact of professional development on teachers' instructional practices, cultural awareness, and empathy in the classroom.

Results

In this section, we present the findings on the impact of PD designed to enhance teachers' ability to maintain cognitive demand, foster productive struggle, and deepen cultural responsiveness in mathematics instruction, particularly for EB students. By examining teachers' reflections and responses to PD activities, we explored how targeted training influenced their instructional choices and awareness of diverse learning needs. The results illustrate shifts in teachers' questioning strategies, an increased emphasis on student autonomy, and a broader recognition of cultural and linguistic diversity. We present the results by the main themes identified in the teacher responses.

"Last Monday" Teacher Responses

Our teachers expressed satisfaction with the PD and observed positive outcomes on periodic evaluation surveys during the first year. However, the lack of details in their responses offered little insight into how the PD helped them. During the second year, the leadership team asked teachers to reflect each month on the last Monday to explain how they were incorporating the PD into their practice. Knowing teachers were reluctant writers, the reflection was structured as "fill in the blank" statements. These statements asked about specific components of the PD, such as productive struggle, challenging students, offering problems learned in training, and sharing their "not-so-stellar" moments (Appendix B). This format allowed teachers to report on specific tasks but was open to any pedagogical or conceptual ideas they applied to their instruction.

There were 408 entries reviewed from the "Last Monday" questionnaire collected between September 2019 and March 2020. These reflections from teachers over time support understanding about how and what the teachers made sense of in the context of their teaching and classrooms. Specific comments about English language learners, culture, and diversity indicated that the PD activities positively impacted the intended direction.

Supporting and Maintaining Cognitive Demand

Responses to these questions demonstrated that teachers were learning how to respond to students without reducing the cognitive load through questioning. For example, one teacher stated, "I pay more attention to the questions I ask. I tend to ask assessing questions and not really advancing questions. I am working on my questioning a lot and I think I am getting better at not making the problems easier for them but asking them to think deeper instead."

Additionally, teachers indicated that they could offer all students challenging tasks, including those who typically struggled in math class:

"With lower-level students, I have done less scaffolding and walked away after I asked a question." ["Walking away" was a specific strategy discussed in PD, as supports offered to perceived struggling students often resulted in the teacher staying too long and providing too much help.]

"I have learned to increase wait time; I have also learned to ask questions like 'What do you know?' when a student says to me 'I don't know.' This [teaching move] had the most impact."

Teacher Insights on Cultural Awareness and Diverse Learning Needs

Comments showed an awareness of culture and language, connections to students, the utility of productive struggle, and allowing student autonomy or voice during math class, pointing to teachers' development of empathetic views of the student experience. For example, one teacher noted, "The topic of emergent bilinguals from the summer training was very helpful this past month when my Spanish-only student needed some help on an assignment in class. I have been doing my best to speak to him in Spanish to make him feel just as safe and welcome in my room. I remember feeling super overwhelmed when Dr. Ewing spoke to us in Spanish for what seemed like forever, but it was only a few minutes. I know that is how my EB student feels in class, and I have been able to connect with him because of my awareness" (October 2019). Another teacher said that the PD made her "more cognizant" of her English language learners.

Attention to student backgrounds was also noted: "Learning about ELL and ESL learners and diverse learners in general from the summer training was very helpful this past month when I realized how many of my students come from culturally diverse backgrounds.

I have tried being more mindful in celebrating all of the culturally different learning styles instead of sticking to just one method that I am comfortable with" (November 2019). Some addressed the issue of diversity more broadly, saying, "Talking about the diversity of students from the summer training was very helpful this past month when I had a new student that I was trying to reach in my classroom. I had to take a big step back and try to understand where she was coming from to help her" (October 2019).

Affect and Empathy

Teachers expressed an understanding of how students feel about problem-solving lessons, framing their own learning about a "positive mindset," productive struggle, a "focus on classroom environment," and "giving students their own voice." For example, one teacher said, "Approaching problems from multiple points from the summer training was very helpful this past month when I had to reexamine student thinking and how I was approaching that in my classroom. It really helped me to connect with students who thought they were not 'getting it.' Approaching problems from different points and engaging students in the discussion about this created a community environment in my room" (February 2020).

One teacher took an extra step to promote empathy between students: "I challenged my students with a task from our training that did not have to do with math but with the understanding that I learned from the training. I had a paraprofessional who spoke Spanish come into my room and introduce a lesson over how to feed monkeys. The students who spoke Spanish laughed because the other students understood the numbers she was saying but nothing else. I did this so my students would understand that sometimes the word 'easy' is not always easy and sometimes it is very hurtful to those who struggle. My classroom had a better outlook on word problems after that" (February 2020).

In early 2020, our teachers did not anticipate the upcoming school shutdowns in response to COVID-19. It was heartening to read comments from March 2020 indicating that connections made during math lessons pre-COVID helped teachers support students during this time. For example, one teacher noted, "I think the biggest takeaway from summer training for this month dealt with multiple perspectives. I had to become okay with being a teacher who needed to rearrange my preconceived notions about how things would/should/could work or be done. One of the things that the training doesn't talk about is the amount of professional knowledge we gain from networking with other great minds. These experiences and information that I have gained have enabled me to be more effective during this transition to online learning" (March 2020).

Discussion

The thematic analyses of teachers' monthly responses to the Monday surveys show that, at minimum, teachers were becoming more culturally and linguistically aware of their students. Like Hunter et al (2020) we believe that this increased awareness helped teachers revise their thinking about the capabilities of their students. Notably, teachers were able to transfer this kind of thinking (e.g., multiple perspectives) during the sudden online shift of spring 2020. Second, we observed that teachers' empathetic views likely led to less lowering of cognitive demand during math class because they became more aware of student perspectives and differences. As noted in Campbell et al (2014), and Cengiz et al (2011) limited opinions of students often lead to reducing the tasks demand in ways that are unproductive for student learning. Finally, the themes indicate that providing tasks during professional development that explicitly target building teacher empathy show promise in enhancing teachers' views about students from diverse backgrounds including those identified as emergent bilinguals. This is evident in the example of the teacher inviting the Spanish speaking paraprofessional to talk to the children in Spanish, this creating space for her students to appreciate and value linguistic differences.

Summary and Conclusions

Recognizing the emotional elements of teaching and learning math through cognitively demanding tasks supports teachers' implementation of these practices so all students can benefit. PD experiences emphasizing the importance of affect or feelings about doing math, particularly for students from diverse cultural and linguistic backgrounds, support an aspect of learning to teach through problem-solving rarely addressed directly in math PD. The three tasks are representative of the tone and overall aim of the PD and provide a level of detail to other researchers and teacher educators to use for themselves and to further interpret teachers' reflections

The Last Monday reflections revealed the many ways teachers connected to student perspectives using what they learned from the PD. Teachers' self-reports are limited in nature, and because they reflected on various experiences from both years, the connection between the three tasks reported here and their comments cannot be claimed solely by these tasks. After experiencing struggles themselves, which allowed them to empathize with ELL/EB students, and visualizing these practices through dramatization, the Last Monday comments showed excitement and interest in providing cognitively demanding tasks to all students.

One persistent issue in professional development projects is whether or not the intervention and its results

have residue and if the PD is effective in increasing student achievement. Desimone's (e.g., 2009) seminal work described essential components of effective mathematics professional development. Relying on this work, which predicts student achievement related to professional development features, our professional development design reflects all five features identified: content focus, active learning, coherence, sustained duration, and collective participation. Our PD included nuance to these features: developing empathy and highlighting the Emergent Bilingual. We believe that a focus on feelings about mathematics and engaging in math tasks with as much attention to the student perspective produces teacher changes that are long-lasting and become internalized. Knowing if these successes after the PD is over is a perennial problem in teacher education. Carpenter, et al (2000) found that if teachers were able to develop certain levels of understanding teaching mathematics as measured by their beliefs and knowledge, teachers who maintained the gains were generative. In other words, they were able to use what they learned in new situations and frequently sought to understand their students' thinking. We believe that our approach of including the empathetic perspective, with a focus on Emergent Bilinguals, provided potential for teachers to sustain their knowledge post PD, although we have not directly examined this claim.

Implications: Empathy as a goal

Professional development often challenges teachers to meet all students' needs and offer engaging, meaningful tasks. However, PD leaders must consider the emotional impact of teaching and learning in new ways (Goroshit & Hen, 2016). Empathetic experiences provide teachers the opportunity to consider and practice the necessary instructional strategies to facilitate productive struggle from the student's perspective. Failure to recognize the necessity of empathy during professional development may lead to lackluster implementation during lessons.

The Importance of Including Empathy Experiences

Providing opportunities for teachers to empathize with their students is increasingly recognized as crucial (e.g., Goroshit & Hen, 2016; Meyers et al., 2019; Rieckhoff et al., 2020). A greater understanding of teacher empathy as a catalyst for student success (Meyers et al., 2019) and the factors contributing to empathy in the classroom is needed, as is insight into how empathy can be developed in PD (Goroshit & Hen, 2016). Maloney and Matthews (2020) noted that empathetic care fosters feelings of inclusion and belongingness in the math classroom. Teachers express empathy in three ways: managing frustration, affirming students' identities as math learners, and sharing struggles with them. Similarly, Meyers et al. (2019) recommend that college professors and their students benefit from an "empathy mindset," which encourages professors to consider their students' lives and circumstances when teaching and making connections through content.

Empathy as a Goal for Professional Development

In math classes, empathetic stances may not come naturally to some teachers. Providing specific opportunities to develop an empathetic mindset during professional development can support both teachers and their students. Our description of three PD tasks, along with responses from our teachers, provides a vision of what can happen in professional development settings. Furthermore, we believe that acknowledging the role of empathy in mitigating the emotional struggles students and teachers may experience in math class is key to successfully implementing the problem-solving, student-centered pedagogies espoused in mathematics professional development.

The AIMM tasks supported teachers in developing a perspective for teaching mathematics that respects students' experiences, thereby building teacher empathy. These three PD tasks demonstrate how the PD provided teachers the opportunity to understand, from the student's perspective, what it feels like on the receiving end of instruction and to reframe their ideas about who can or cannot do the mathematics required to solve challenging tasks. Using these tasks also revealed new insights for math educators which increase their empathy for teachers as they take on the challenges of using problem-solving, student-centered lessons.

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Appendix A:

Teacher-student interaction and possible teacher responses to be used with Rosca De Reyes Task.

Interaction	Script	Analysis/Possible Responses
1	(The teacher approaches Veronica, an ELL student, who seems to be having difficulty getting started.) Teacher: Do you like Rosca? Veronica: (shyly)Yes. I like it.	[This question is affective and invites the student's own ideas. Teachers should allow students time to make sense of the problem context on their own before asking mathematical questions.]
2	Teacher: What is the question asking? Veronica: If I will get the baby...?	[This question assesses what the student knows about the problem.]
3	Teacher: How do you say "probability" in Spanish? Veronica: La probabilidad!	[The question assesses the student knowledge of probability using the Spanish vocabulary equivalent. The teacher shows appreciation for Spanish and is able to assess the student's understanding of the concept of probability and vocabulary development.]
4	Teacher: How can we calculate the probability or la probabilidad? Veronica: (smiling) We need to know how many slices there are in the "Rosca."	This draws the students' attention to the open-ended structure of the task and the student recognizes that more information is needed.]
5	Teacher: How would you like to solve the problem? Veronica: Let's say ten slices. It depends, but we usually share the cake with our neighbors. Let's say ten slices of cake.	[The teacher's question invites the student to provide relevant details. Now the math is personal to the student.]
6	Teacher: What is the probability that you get the plastic baby in your slice of cake? Veronica: (she hesitates for a second) If there are ten slices and I have one slice, then the probability is 1 out of 10 that it is in my slice.	[The question supports the student to focus on the mathematics and can be characterized as an assessing question.]
7	Teacher: Awesome! How will you write down your answer? What if there are more than 10 people? What if some of the neighbors don't come? Can you figure out some more ways that Veronica might get a slice with the baby in it? Veronica: I am not sure. I guess I can try 8 people?	[The teacher now knows that Veronica understands the problem context and knows something about probability. This question advances the student to consider more situations and additional probability statements.]

Appendix B: AIMM Last Monday -Monthly Survey

AIMM Teachers are required to provide monthly reflections on the LAST MONDAY of the MONTH.

Our AIMM Team would like for each teacher to reflect on their teaching throughout the grant program. On the Last Monday of the Month, we will require teachers to complete the following sentence stems related to our grant program's main concepts. The stems are designed to help teachers construct their thoughts related to these concepts. Teachers have the freedom to elaborate beyond the designed structure of each sentence stems.

1. Over the last month, I elicited student thinking by _____ and my best example was when _____.

2. Over the last month, my students engaged in productive struggle when _____, and I was very proud of my students when _____.

3. I had some not-so-stellar teaching moments this past month. There was this time when I wish I would have _____ when _____.

4. I challenged my students with the _____ task from our training, and the students _____.

5. I used the iPad in my teaching this past month when I _____.

6. _____ from the summer trainings was very helpful this past month when _____ happened in my classroom.

7. During this program we have explored the concept of _____, and I have been able to _____ in my classroom.

8. During this program we have explored the concept of _____, but I have been unable to _____ in my classroom.

9. Please provide any additional information you desire.